satisfy everyone. He gives us a marine Lower Devonian series across south-west Ireland (Fig. 19), the Glengarriff Grits being supposed to represent the deposits of a land-locked bay. He carries the Upper Senonian sea (Fig. 53 and p. 333) boldly into Scotland, Wales, and central Ireland, though flints are scarce in the surface-deposits of some of the areas thus invaded, and though they are not likely to have been carried away by subsequent marine action (compare p. 426). The rapidity of the oscillatory movements in Cretaceous times is properly insisted on, if we are to regard the chalk as a deep-water rather than merely as a pure-water deposit.

The consideration given by the author to the conditions under which successive series were formed is well seen in his comparison of the Bunter pebble-beds with the alluvium of the Helmand River (p. 234), or in his very interesting discussion of the Pliocene and Pleistocene deposits (pp. 404–61). The references to recent literature show how keenly he has watched the progress of research. We thus have Mr. Hickling's views on the Permian affinities of the outliers of sandstone near Dumfries, which are often supposed to be of Triassic age (p. 208); Prof. Watts's suggestion (p. 379) of the Eocene age of igneous rocks in the English Midlands; and Mr. Bernard Smith (p. 237) on the "skerries" of the Keuper marls. Anyone who has become attracted by the varied surface of our islands, or even by the scenery of a single county, will find his views enlarged when he follows Mr. Jukes-Browne into the past. He will at once feel the complexity of the subject, and the vast range of the events that have determined the present forms of hill and dale. After reading a few pages, a healthy reaction sets in against the superficial physical descriptions in which we all are liable to indulge. No one can read "The Building of the British Isles" without becoming again a student. The author's expressions of personal opinion will stimulate inquiry rather than remove all doubt. This is the manner of the true scientific teacher, and we feel that Mr. Jukes-Browne has made new claims on our regard.

To enjoy a book so full of detail, one must see and remember the country it describes. In ten years, in holidays of a few days at a time, the geologist may learn a great deal of the aspect of our islands. To anyone who has happily crossed the open country, from the rocky coves of Cornwall to the heather-covered slopes above the Moray Firth, or from the sunlit dunes of Donegal to the grey mud-flats near the Nore, these pages will make a singular appeal. Perhaps we may read into the book a good deal obtained from other sources, since it presupposes a general knowledge of the great tectonic movements that have affected the European area. In spite of what we have said, it is intended primarily for the geologist.

Every British or Irish geologist, moreover, will find points that he will like to criticise. Why, for instance, should stratified gravels be difficult to understand (p. 440) on the hypothesis that they result from the washing of boulder-clay? Does not the melting ice supply the very agent for their stratification? A "very deep basin" would not be required (p. 128) for the accumulation of the Cornstone series in Wales, but only a continuously subsiding floor. The omission of the Snowdon area from the description of the Ordovician rocks of North Wales seems surprising (pp. 68 and 69), and no stranger would suspect the immense part played by volcanic action in originating the scenery between the Conwy and Llanberis. Other geologists, however, must now enjoy the book, and discover their particular grievances to the author, who has done so much to help them. G. A. J. C.

TECHNICAL THERMODYNAMICS.

Applied Thermodynamics for Engineers. By Prof. W. D. Ennis. Pp. viii+438. (London: Constable and Co., Ltd., 1910.) Price 24*s.* net.

THIS is by far the most comprehensive book published in the English language on the subject of technical thermodynamics. It contains an account, brief but lucid, of the transformations of heat and mechanical energy which occur in almost every conceivable industrial process. As evidence of this widespread treatment, it is only necessary to mention that among the processes discussed are the development of power in the internal combustion engine, in the steam engine, in the hot-air engine, air and gas compressors, distillation plant, mechanical refrigeration, fusion and liquefaction of gases. To the discussion of these various topics Prof. Ennis brings experience gained in the mechanical engineering side of the Polytechnic Institute of Brooklyn, and it is clear that in his study of these problems he has made a digest of recent work on the subject of gases and vapours. His style of writing is graphic, forceful—but eccentric in so far as he seems actually to seek opportunities for splitting the infinitive; in fact, he does so no fewer than four times in the first five pages of the book, and after that we gave up counting.

A useful feature is the appendage to each chapter of a brief synopsis of its contents, together with a bibliography of the authorities quoted. Problems are added for the use of students, but the author does not commit himself to their solution, a cautious step in a first edition.

Prof. Ennis's immediate aim is expressed in the following words:—

> "Thermodynamics is physics, not mathematics or logic. This book takes a middle ground between those text-books which replace all theory by empiricism and that of the other class of treatises which are too apt to ignore the engineering significance of their vocabulary of differential equations. We here aim to present ideal operations, to show how they are modified in practice, to amplify underlying principles, and to stop when the further application of those principles becomes a matter of machine design."

The author may fairly be said to have carried out these intentions successfully, in spite of the necessarily considerable labour which must have gone to the compilation of so compressed a treatise.

It is not possible to discuss at length the methods followed by the author even in a section of the subjects he deals with, but some call for passing notice. Thus, he introduces early the idea of increasing specific heats of gases, and uses a formula

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of the form $k=a+bT$, which he applies to the calculation of entropy. He shows that when expansion follows the path (called a "polytropic" path) $p\ v^n=$ constant, the rate of heat absorption or emission is directly proportional to the temperature change, and the author therefore deduces that the "specific heat" *must* be constant along any such path. This seems confusing when it is realised that this particular proof rests on the hypothesis of a constant specific heat, but investigation shows the confusion to be due to a somewhat loose use of the term "specific heat." This may prove a stumbling-block to some readers. After a careful and necessarily compressed account of the basic thermodynamic laws, the author gives an account of the properties of entropy, and of the limitations to be observed when non-reversible cycles are being studied. He rightly points out that many of the most important engineering processes are not even "cyclic," to say nothing of their not being "reversible." He remarks—

> "A careful distinction should be made at this point between the expression $\int \frac{dH}{T}$ and the term 'entropy.' The former is merely an expression for the latter under specific conditions . . . perhaps the most general statement possible for the second law of thermodynamics is that all actual processes tend to increase the entropy; as we have seen, this keeps possible efficiencies below those of the perfect reversible engine." He concludes, however, that "most operations in power machinery may, without serious error, be analysed as if reversible; unrestricted expansions must always be excepted. The entropy diagram to this extent ceases to have an automatic meaning."

We seem here to be getting nearer to the desired harmony between the various views, as to the nature of entropy and its utilisation, which have been expressed in the past. Brief as the author has found it necessary to make his description of the action in a gas producer, he has been able, we are glad to see, to consider the important case where exhaust products are employed instead of steam as a "heat reservoir," and he gives on p. 153 an interesting diagram comparing the two alternatives, which should prove very useful in practice.

It may be a surprise to some readers to find that, contrary to the usual custom, the internal combustion engine is dealt with before the steam engine; but since the study of gases is easier than that of vapours, it is in reality a rational sequence to adopt. The section on the steam engine is very complete, and includes an account of wire-drawing, condensation, steam-jacketing, superheating, compounding, the use of turbines, boilers, drafts, fans, chimneys, stokers, economisers, pumps, and injectors. It would have seemed rash to forecast that so many subjects could be treated in one book, but the author has succeeded in including all this, and more, in his four hundred and forty pages.

In conclusion, we have no hesitation in welcoming the book as a valuable addition to the literature of the subject. It will be of special use to scientific engineers, to practical physicists, and to that growing student class which aspires to become the one or the other.

THE SOURCES OF EDUCATIONAL THEORY.

The Child's Inheritance: its Scientific and Imaginative Meaning. By Dr. G. Macdonald. Pp. xii+339. (London: Smith, Elder and Co., 1910.) Price 12*s.* 6*d.* net.

THIS book, which some readers will find prolix and whimsical, but all must acknowledge to be eloquent and sincere, seeks the ideal form of the educational process as a development of the child's racial inheritance.

> "In the understanding of the child's inheritance both the poet and the biologist are worth deep and close study, not because they are necessarily antagonistic, but because, if they understood each other better, the gain to education would be incalculable."

For this reason the author directs us to Wordsworth's "Prelude" and Weismann's theory of the continuity of germ-plasm as the best sources of educational doctrine. The synthesis is original, and Dr. Macdonald is probably right in thinking that Weismann "would find his place somewhat unexpected while standing as the poet's squire." He would possibly be still more astonished at his proximity to William Blake, who is also repeatedly quoted.

Dr. Macdonald has published elsewhere a lecture on "The Sanity of William Blake." The citations in the present work certainly indicate that a teacher with the right temperament may learn much professional wisdom from the mystical poet. With the aid of these oddly consorted authorities the author discusses the nature and interaction of the child's endowment and environment. The former is "the old world within"—the epitome, as Haeckel taught, of phylogenesis. The latter is "the new world without," which, by imitation, by suggestion, and in other ways, moulds the plastic substance of the child's mind. Examining in further detail the interplay between these fundamental factors, the author finds two processes or aspects of mental growth to be of the first importance—expression and imagination. The chief means of expression is "the service of the hand." The discussion of this topic is rather one-sided, but is nevertheless an interesting and valuable contribution to a subject of much present importance.

The chapter on imagination—described as "that something in the child which recognises the shining light in all things living"—gives occasion for some not ill-founded criticisms of existing views of man's nature and of educational practices based on them. The chapter headed "Faith and Recreation" contains an admirable doctrine of the functions and value of play. In an intermediate chapter "On Specialisation," the author is led by his favourite thesis that mental life is more than "an assembly of various functions" to combat vigorously any form of specificity in education. It is perhaps unfortunate that a criticism of education, which, though ill-balanced and occasionally extravagant, must on the whole command respect, should lead to this position. For many of us feel that vocational education, properly understood, is the most hopeful means of giving the child effective possession of his inheritance.

T. P. N.

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